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1	Request for more detail in the description of the low-pass filtering used in the analysis of the salt front	The analysis examining salt front location as a function of discharge was performed using the model application documented in the hydrodynamic model report (HydroQual 2008). For purposes of this analysis, the salt front was nominally described as the location of the 2ppt isohaline at the bottom of the water column. The analysis involved first determining the salt front location time-series using the results from an ECOM model simulation over water years 1995 through 2004. The time-series of the salt front location was parsed through a Fast Fourier Transform (FFT) to decompose the time-series signal into a number of harmonic constituents. The major constituents returned from this analysis represent dependencies of the salt front location with the tidal constituents, discharge, and offshore set-up and set-down events, with each constituent characterized by a unique frequency or period. In order to filter out the effect of the tides from the salt front location, the constituents from the FFT were low-pass filtered to exclude harmonics with frequencies greater than 0.2 cycles/day, i.e. with period less than 5 days. The remaining constituents, representing the dependency of the salt front with discharge and other low frequency forcings, were parsed through an inverse FFT to reconstitute the time-series of salt front locations, and plotted against the corresponding daily Dundee Dam discharge. This analysis will be included in a report currently under preparation documenting the CPG's updates to the LPR hydrodynamic model received from EPA and the hydrodynamic model validation with the PWCM data, CWCM data, and the high-flow data from Bob Chant in March 2010.
2	Justification for the decision to base the skin friction calculation on the initial D50 of the bed	Time-variable D50 for calculating skin friction was tested again as part of the recent updates to the model and the model performance is summarized herein. Although model performance using time-variable D50 is comparable to the base calibration run with constant D50 (the model calibration described in the August 2014 memorandum) during low-flow conditions, during high-flow conditions such as during the March 2010 event and Hurricane Irene, the results tend to deviate, with much larger erosion calculated in the sensitivity run. Figure 1 shows a comparison of measured and model-calculated suspended concentrations during the March 2010 storm event from the sensitivity run using time-variable D50. The model results on average are biased higher than the data, over-predicting by more than a factor of 5 in some cases. A similar bias between the results from the sensitivity run and the measured bathymetric changes occurs during Hurricane Irene as well. In order to examine the reasons for the difference in performance between the sensitivity and the calibration run, the bed mechanics during a 16,000 cfs storm event in April 2007 have been analyzed

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		and presented in Figure 2. This particular event and time-period was selected because this is the first such event of this magnitude in the long-term calibration hydrograph (WY1995-2013), and because the sensitivity run produces disproportionately higher erosion during this event than during the following 16,000 cfs event in March 2010. Figure 2 shows the bed mechanics for a cell at RM 4.2 during a two-week period surrounding the storm event for the base calibration run (left plot), and the sensitivity run (right plot). The various panels indicate the discharge and tidal forcings, D50 of the surface layer, skin friction and critical shear stress of the surface layer, bathymetric change, and the near-bottom suspended sediment concentration. Temporal variation in the D50 is more or less similar in the two runs; however, the resulting skin friction is a factor of two higher in the sensitivity run, and as high as 35 dynes/cm^2 during the peak of the hydrograph. Because of the coarsening of the surface layer with the erosion of the smaller size classes, the surface D50 increases to 3000-4000 microns, leading to an increase in the grain roughness and therefore skin friction in the sensitivity run. Comparing the peak skin friction in the sensitivity run (35 dynes/cm^2) to the critical shear stress for erosion of the largest size class in the CPG's model (31.8 dynes/cm^2) shows that the shear stresses generated in the sensitivity run erodes every single sediment class in the bed, leading to a scour of ~2 meters in this cell and several others during this event. The impact of the higher erosion in the sensitivity run is also apparent in the suspended sediment concentrations, reaching as high as 10,000 mg/L, a number more than an order of magnitude higher than the highest concentrations ever measured in the LPRSA. In contrast, the base calibration run calculates skin friction lower than the critical shear stress for erosion of the largest size class, and as a consequence the largest size class provides the armoring mechanism that prevents the model from calculating similar erosion as the sensitivity run. For comparison, the base calibration only calculates ~10cm of erosion and ~1000 mg/L suspended sediment concentrations at the same location, numbers consistent with various measurements during an event of similar magnitude in March 2010.
3	Updates to the simulation of historical infilling	The simulation of historical infilling presented in the January 2013 memorandum was repeated using the model parameterization presented in the August 2014 memorandum. This is mainly a qualitative test of the model's capability in representing the historical infilling of the LPR following the last major dredging event in 1949. Therefore, the model bathymetry was defined as an approximation of the conditions in the LPR, NB, and the Kills during this time period. Accordingly, model bathymetry within the navigation channel in the lower 8 miles of the LPR was set at the federally mandated navigation channel depths (RM 0-2.6: 30 ft, RM 2.6-4: 20 ft, RM 4-7.8: 16 ft; depths relative to MLW). Within NB and the Kills, the bathymetry was approximated based on maps showing the historical

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		evolution of Newark Bay (USACE 2006) – major features represented are a 30 ft (relative to MLW) channel in the Kills leading to Port Newark and the LPR, and the absence of the Port Elizabeth, Port Elizabeth pier-head, and Port Elizabeth channels with the bathymetry in these areas set at 5 ft (relative to MLW). Other inputs specific to this historical infill simulation relate to the solids loadings from Dundee Dam and the Kills. Given the objective of simulating the historical infill following the 1949 dredging in the LPR, the solids loadings from both Dundee Dam and the Kills were defined to be representative of the historical loadings rather than the loadings under current conditions used for the calibration run. The solids loadings from Dundee Dam were defined using the solids load-discharge rating curve developed by Region 2 for the FFS model, which as described in the August 2014 memorandum may likely be more representative of loadings in the 1960s than current conditions. Similarly, the solids loadings from the Kills were defined using the rating curves derived by Region 2 for the FFS model using data collected by Chant (2006) in 2000-2002, prior to the implementation of the 50' channel deepening project in NB and the Kills. All other model inputs and parameters were as defined for the calibration simulation. The results from this simulation and its comparison to the measured infill are shown in Figure 3. Following EPA comments to the January 2013 report, the measured sedimentation rates were determined by comparison of the post-dredge bathymetry to the next available bathymetry survey which between RM 2.5 and 6.8 involved comparing the 1949 and 1966 surveys, and below RM 1.4 involved comparing the 1983 and the 2004 surveys. The bathymetric change for both model and data are presented as an annualized sedimentation rate. Both data and model show much higher infill rates in the lower miles, with sedimentation rates occasionally in excess of 15 cm/yr, than at locations further up-estuary. Similarly, in both model and data, sedimentation rates show a slight decrease from RM 1 to RM 0, a feature likely related to shipping activities and associated scour in this reach of the LPR. Above RM 2.5, both the model and data show relatively high infill rates along the southern edge of the navigation channel between RM 2.5 and 3.2, and in the inner bend at RM 4, and towards the shoal at RM 4.2. Similarly, both the model and data show lack of infill in the bend at RM 4.7, and in the vicinity of the Bridge St, Clay St, and I280 bridges (RM 5.5-6.5). Notable locations with a discrepancy between model and data include the vicinity of RM 5, RM 7, and the inner bend at RM 3.5. An exact match is not to be expected between the model and the data for reasons including the fact that the system never had a bathymetry as exactly simulated with the complete mandated

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		navigation channel all dredged at the same time, the differences in the hydrograph during the years spanning the data versus the hydrograph used in the model, lack of information on the historical solids loadings, differences in sedimentation rate over time (sedimentation rates would be expected to be highest during the period immediately following dredging and decrease subsequently), as well as uncertainties associated with the interpolation and comparison of the historical single-beams transect data. Therefore, this comparison is mainly for a qualitative assessment of the patterns of infilling and for a high-level assessment of whether the model as formulated and parameterized is capable of reproducing the infill expected following a dredging event. In general, the model, can be said to reproduce the infill process that has been historically observed within the LPR. Following EPA comments to the January 2013 report, the evolution of the bed composition (cohesive fraction of the top 15cm of the sediment bed) in the LPRSA has been assessed relative to various core/grab sample data and presented in Figure 4. The comparisons are presented over 2 mile sections of the LPR. In the upper miles, between RM 6-18, the model shows relatively small deviations from the initial condition, with the deviations tending towards the distribution of the measured cohesive content. In the lower 6 miles, which are predominantly depositional in this particular simulation, although the model calculates a distribution that is similar in shape to the data distribution, the model has a tendency to calculate a finer composition than measured. This may likely be related to the uncertainty in the composition of the historical solids loadings from Dundee Dam. The historical infill simulation relied on recent water column composition measurements for low-average flow conditions, and the approach developed by Region 2 for high-flow conditions. As described in the August 2014 memorandum, the solids loadings at Dundee Dam appear to have changed from the 1960s to current conditions; however, the composition associated with the loadings in the 1960s is unknown. In response to EPA comments to the January 2013 report, model calculated sedimentation rates in Newark Bay are also presented, in Figure 5. Model simulated bathymetric changes in Newark Bay are relatively small in this simulation, with erosion limited to the navigation channel and its vicinity (typically in the range of 0-1cm/yr), with the remainder of the Bay experiencing a similar magnitude of deposition.
4	Please describe changes made to the sediment transport model	The changes made to the sediment transport model as part of the process of combined calibration with the CFT model relate only to model inputs and outputs. Specifically, no sediment transport

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	based on the CFT model.	model calibration parameters were modified as a consequence of the calibration of the CFT model. The individual changes are listed below. • LPR bathymetry – Initial runs with CFT model showed a decline in bed contaminant concentrations in certain localized areas (e.g. RM 7.5); trends somewhat inconsistent with available information on sediment contaminant concentrations. This decline in concentrations was identified as a consequence of too much deposition due to a model channel cross-section larger than suggested by the various bathymetry surveys in the LPR. Therefore, the bathymetry data in the LPR was analyzed and used to develop a revised model bathymetry. • Bed density profile for depositional layers – In the January 2013 version of the CPG's ST model, the bed consolidation model was parameterized such that the consolidation model reproduced the erosion properties specified for the parent layers. The erosion properties of the deposited layers were the primary parameter of interest. However, the resulting bed dry density profile that although started at a realistic 0.5 gm/cm^3 at the surface of the bed, tended to a somewhat unrealistic (for predominantly cohesive sediments) 1.1 gm/cm^3, the fully consolidated value at depth. Since the dry density profile controls the sedimentation rate achieved by the model, and since the sedimentation rate is a primary parameter of interest for the CFT model, the consolidation model was re-parameterized to reproduce dry density profiles derived from the LPR core data. • Sediment bed initial conditions – Although not a change as a consequence of the CFT model application/performance, in developing the revised bed initial conditions described in the August 2014 memorandum, core data collected within the silt pockets above RM 8 were treated as a separate category (other two categories include data inside and outside the former navigation channel); this parallels the assignment of bed initial conditions in the CFT model. The silt pockets were delineated using the "silt" category in the 2005 Side-Scan Sonar data (Aqua Survey, 2006) and using the probing data collected as part of the various RI/FS sediment sampling programs. Separate properties for the silt pockets are supported by the resulting average values from the core data within these areas. • Linkage with the Organic Carbon Model – The original output files for the linkage with Organic Carbon model were modified to include additional output related to the bed thickness, and the

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		composition in the active and archive layers.
5	The CPG critical shear stress profile being used (1.5X average tau_crit) appears to align better with the data (Figure 2) and these new values are as much as 2-3 times smaller than those derived from the 6X magnification of tau_crit.	-
6	Please provide additional detail in the description of the OBS data binning process (e.g. bin size) and improve the quality of Figure 3.	Figure 6 and Figure 7 include enlarged versions of the graphics included in Figure 3 of the August 2014 memorandum. The OBS data binning procedure was set up to give approximately similar weight to the binned OBS-SSC/discharge pairs and the water-sample/discharge pairs in determining the shape of the resulting load-discharge rating curve. The procedure involved dividing the range of discharges in base 10 log-space (231-10,300 cfs) available for the OBS data into equidistant bins, with the bin size (bin size of 0.014 in base 10 log-space) chosen such that the resulting total number of binned discharge/OBS-SSC pairs were approximately equal to the number of water-sample/discharge pairs (n=147). The Spring and Fall OBS-SSC/discharge time-series were binned separately using this binning interval, yielding a dataset of 87 binned OBS-SSC/discharge pairs for the Spring dataset and 53 pairs for the Fall dataset.
7	References to the presentation made at the March 13, 2014 modeling oversight meeting as part of the discussion of the comparison of the Gust Microcosm data and the fluff layer erosion parameterization should be replaced with the actual figures. A copy of the presentation from the March	The Gust microcosm experiments (CBA, 2006) involved sediment cores collected from six locations (with duplicate cores at each location) in the LPRSA in 2005. The cores were relatively short (~10cm), with some cores taken from locations in the shallows and some within the channel, and with the exception of one core at RM 11, the rest of the locations were within the lower 8 miles of the LPR. The cores were subject to erodibility measurements using a Gust Microcosm, involving a series of incrementally increasing shear stresses paired with simultaneous measurements of the suspended sediment concentration in the overlying water column for an estimate of the sediment mass eroded under the imposed shear stress. Using this data, and fitting the erosion rate as a linear function of the excess shear stress (Equation 1, where E=erosion rate, M=erosion rate parameter, τ=shear stress, and τ_{Cr}=critical shear stress for erosion), CBA (2006) reports the cumulative eroded mass, which is a

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	13, 2014 oversight meeting should be provided to EPA.	surrogate for the depth of erosion, τ_{Cr}, and M. $$E = M(\tau - \tau_{Cr}) \quad (1)$$ The Gust Microcosm measures the erodibility of a relatively thin veneer at the sediment surface in contrast to the depth intervals measured by Sedflume which typically extends to deeper strata. Since the CPG's model application involved the parameterization of the erodibility of a surface layer of easily erodible sediments (the fluff layer, parameterized using an analysis of PWCM data) overlying more consolidated sediments (parameterized using Sedflume data), model inputs developed for the fluff layer were compared to the Gust Microcosm data as an independent verification of the model parameterization. Figure 8 shows the measured depth profile of the critical shear stress for erosion from the Gust Microcosm experiments. Each panel includes results for the duplicate cores taken at each location. The measurements of cumulative eroded mass for each core were converted to an equivalent depth in the bed assuming a dry density of 360 kg/m^3, a number similar to the model parameterization for surface dry density. The resulting depth-interval sampled by the Gust Microcosm is seen to range only up to ~2mm indicating the shallow pool of sediments eroded during the experiments. The main feature apparent in the data is an order of magnitude increase in the strength of the bed, or the critical shear stress for erosion, within the top 1-2 mm of the cores. This supports the CPG's model construct, with a fluff layer (characterized by a relatively low critical shear stress for erosion) overlying less erodible layers (characterized by relatively high critical shear stress for erosion). The increase in critical shear stress from the fluff layer to the underlying less erodible layer parameterized in the model is also similar, approximately an order of magnitude. The depth profile of the erosion rate parameter M was also examined in a similar fashion as the critical shear stress for erosion as shown in Figure 9, with no clear and consistent patterns apparent. In addition, these measured erosion rate parameters were also compared to the equivalent model inputs for a direct assessment of the model parameterization. As described in the January 2013 report, the equivalent model input which is the coefficient A in the ECOM-SEDZLJS erosion formulation (Equation 2, where A=erosion rate coefficient, and n=power term), was derived from an analysis of the entrainment rates measured in the PWCM data.

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		$$E = A\tau^{n} \qquad (2)$$ However, as seen from the comparison to Equation 1, the two formulations are somewhat different. Therefore, for comparison to the Gust Microcosm measurements, the PWCM data was reanalyzed and the entrainment rate (equivalent to erosion rate for purposes of this discussion) was plotted against the excess shear stress assuming τ_{Cr}=0.25 dynes/cm^2 (same as the model parameterization for the fluff layer). Figure 10 shows the resulting relationship, with the trend best characterized by a power function (Equation 3) with coefficient A=1.1e-5 cm/s/□cm/s/oef□□^{n}, and n=0.75 $$E = A(\tau - \tau_{Cr})^{n} \qquad (3)$$ However, n≠1, and given the objective of comparing to the erosion rate parameter from the Gust Microcosm experiments, Equation 3 has been approximated as a linear function of the excess shear stress with A=1e-5 cm/s/dynes/cm^2 or 3.6e-4 kg/m^2/Pa assuming dry density of 360 kg/m^3. This is the equivalent of the erosion rate parameter M from the Gust Microcosm experiments and is compared to the full range of measured M values over the various depth intervals in each core, as well as an average M per core in Figure 11. The left panel includes data from all the sites, and the right panel only includes the cores from the lower 8 miles which are characterized by predominantly fine sediments. The value of parameter A resulting from the linear approximation of Equation 3 is indicated by the dashed line and is seen to be comparable to the median of the distribution of average M for each core. Over the range 0.1-4 dynes/cm^2 of excess shear stress, the power function in Equation 3 calculates erosion rates that are between -25% and +90% of the erosion rates from the linear approximation of Equation 3. Incorporating this range into the value of A from the linear approximation results in the grey shaded region indicated in the probability distributions in Figure 11, with the range of values resulting from the power function also seen to be within the range of measured M values. These comparisons to measured erosion rate parameters provide an independent verification of the CPG's model parameterization of the erodibility of the fluff layer.
8	The navigation scour hypothesis is a good idea to investigate, and the resulting analysis seems to support the theory that vessel activity may be the largest	Navigation scour within Newark Bay will be examined as part of the model application to Newark Bay. An alternate approach, depending on the availability of suitable information, can be evaluated at that time.

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	contributor to scour in that area. However, navigation scour in the navigation channels in Newark Bay needs to be incorporated in the model and the approach used for the lower two miles of the LPR can not applied to Newark Bay because the "equilibrium depth" approach used in the LPR is not appropriate in the dredged navigation channels of the bay. An alternate approach based on the physical setting and navigation conditions should be developed to allow a consistent approach to be applied across the model domain.	
9	Solids estimated from acoustic backscattering data obtained in the PWCM program should be plotted and compared to model simulated TSS for each sigma level as a means of evaluating the effect of the varying settling velocities on the vertical distribution of computed water column solids.	Figures showing the model-data comparison for each model sigma level along with prediction intervals for the ABS-estimated TSS are included as a separate attachment.
10	The description of the model-data comparisons for the March 2010 storm (Figure 20) states	The model-data comparisons for the three transects measured by Bob Chant and shown in Figure 20 of the August 2014 memorandum were based on model output post-processing that did not account for the 8m datum adjustment in the model. Similar comparisons using the water sample data

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	"Most calculated values are within a factor of two of the measured values, especially for transects 2 and 3 and for the water samples collected by the CPG, whereas for transect 1 the model tends to underpredict the measured values." It appears that transect 3 has a substantial fraction of the points less than a factor of two of the data, similar to transect 1. Please clarify if the text accurately describes the relative agreement achieved for transects 1 and 3.	collected by the CPG are not affected by this revision since those comparisons are only at the water column surface. Revised model-data comparisons for the three transects are shown in Figure 12. Most model-calculated values are within a factor of two of the measured values; only transect 3 shows an appreciable fraction (about 40%) of the comparisons outside the factor of two envelope around the measured values.
11	It is also noted that (MPI, 2007b) is used as the reference for the return period for high flow events. The return periods should be updated to account for more-recent flow data.	We can perform an analysis of the return frequency similar to the MPI (2007b) reference and include it as part of the report on the LPR hydrodynamic model.
12	Figures 31 and 32 need to be replaced with better quality figures, and without cropping portions of the legends. The comparisons of surface and bottom water column solids from the CWCM program (Figures 32 and 33) show considerable biases, which highlight the benefit of	Figure 13 and Figure 14 show better quality images of the model-data comparisons presented in Figures 31 and 32 of the August 2014 memorandum.

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	comparing the vertical variations of model results and data available from the ABS measurements from the PWCM program (mentioned above).	
13	Bathymetry differences over the spatial extent of model grid cells from multibeam survey data do not need to be filtered for changes of more than 0.5 feet. Considering that the CPG is intending to use exposure concentrations from a 2 cm depth interval of the sediment, the performance of the model on fine vertical scales needs to be demonstrated.	The final LPR ST report will not include panels excluding changes less than 0.5 ft
14	Model performance is linked to "lack of spatial variability in the Sedflume erosion data." Please clarify this statement, which is assumed to refer spatial variability in erosion rates incorporated in the model?	The statement refers to the lack of spatial variability in the erosion rates incorporated in the model. However, this lack of spatial variability in the model is a consequence of the lack of any spatial variability that could be reliably identified in the 2005 LPR Sedflume data. In contrast, analysis of the Newark Bay Sedflume data shows spatial variability likely related to dredging history, sedimentation rates, and consolidation effects, relationships that are conceptually reasonable and not unreasonable to expect within the LPR as well.
15	EPA disagrees with the final paragraph of the memo, which states that the CPG lacks data and information for calibration of the sediment transport model of the Newark Bay portion of	The statement in the memorandum "*the CPG currently lacks data and information necessary to complete the Newark Bay portion of the model and is awaiting a determination from Region 2 and the Newark Bay respondents on a plan for collecting RI data necessary for the model*" relates to the overall Newark Bay modeling study, including the CFT and bioaccumulation components in addition to the hydrodynamic and sediment transport models. The primary datasets for the development and

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	the domain.	calibration of the sediment transport model in Newark Bay are available.
16	It is also noted that EPA recognizes that the relationship between suspended solids and ABS for the spring 2010 PWCM data have not been finalized, it is expected that these data will be incorporated in the boundary conditions at the tidal boundaries.	The model application summarized in the August 2014 memorandum relies on data collected by Bob Chant during 2008-09 to characterize the boundary conditions at the Kill van Kull and Arthur Kill. It is anticipated that the 2010 Spring PWCM data at these locations will likely be very similar given its proximity in time to Bob Chant's data. The Spring PWCM data will be included as part of the model application to Newark Bay.

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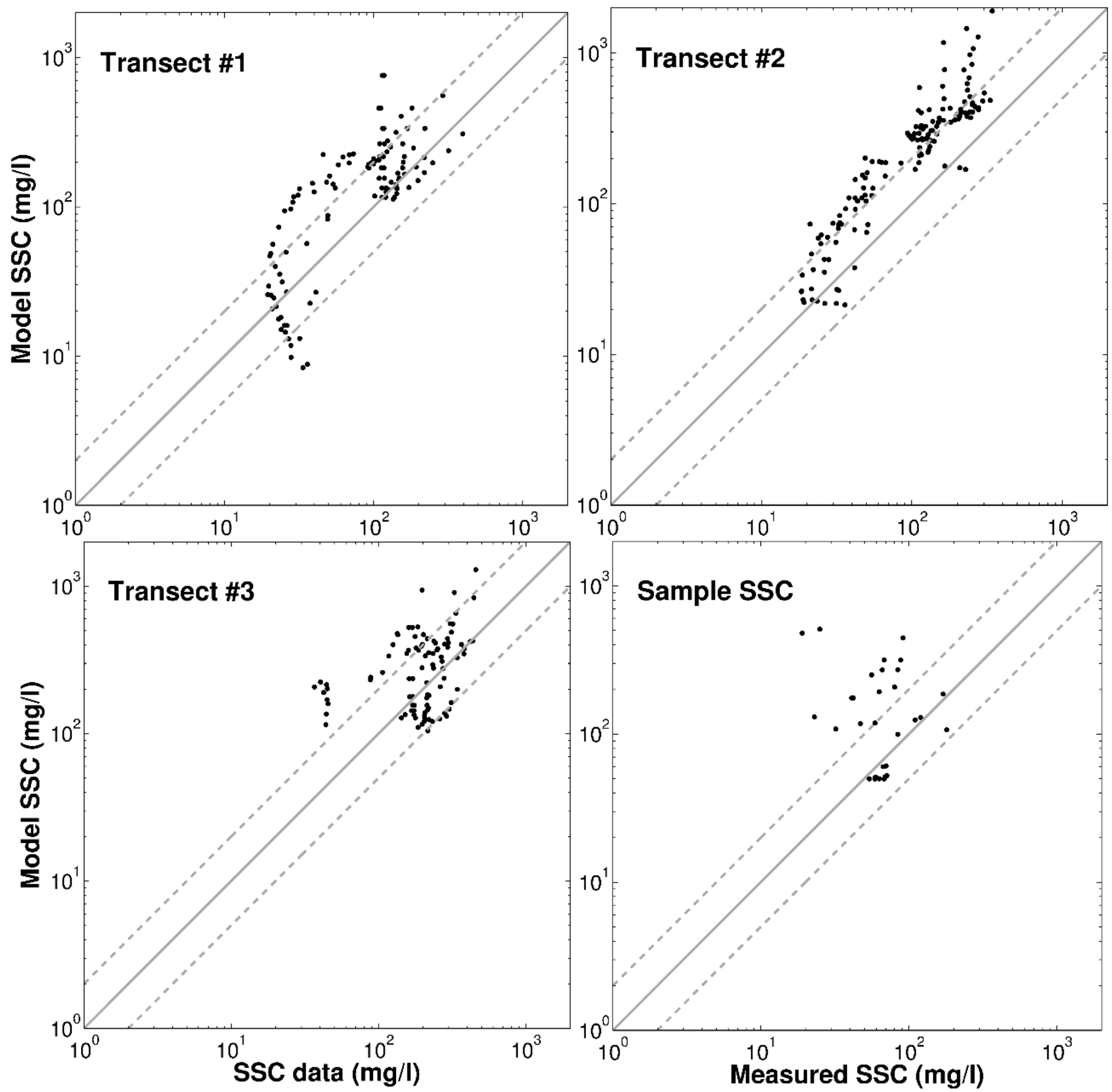

Figure 1. Model-data comparisons for the high-flow event on March 16, 2010 from a model sensitivity using time-variable D50 to calculate skin friction

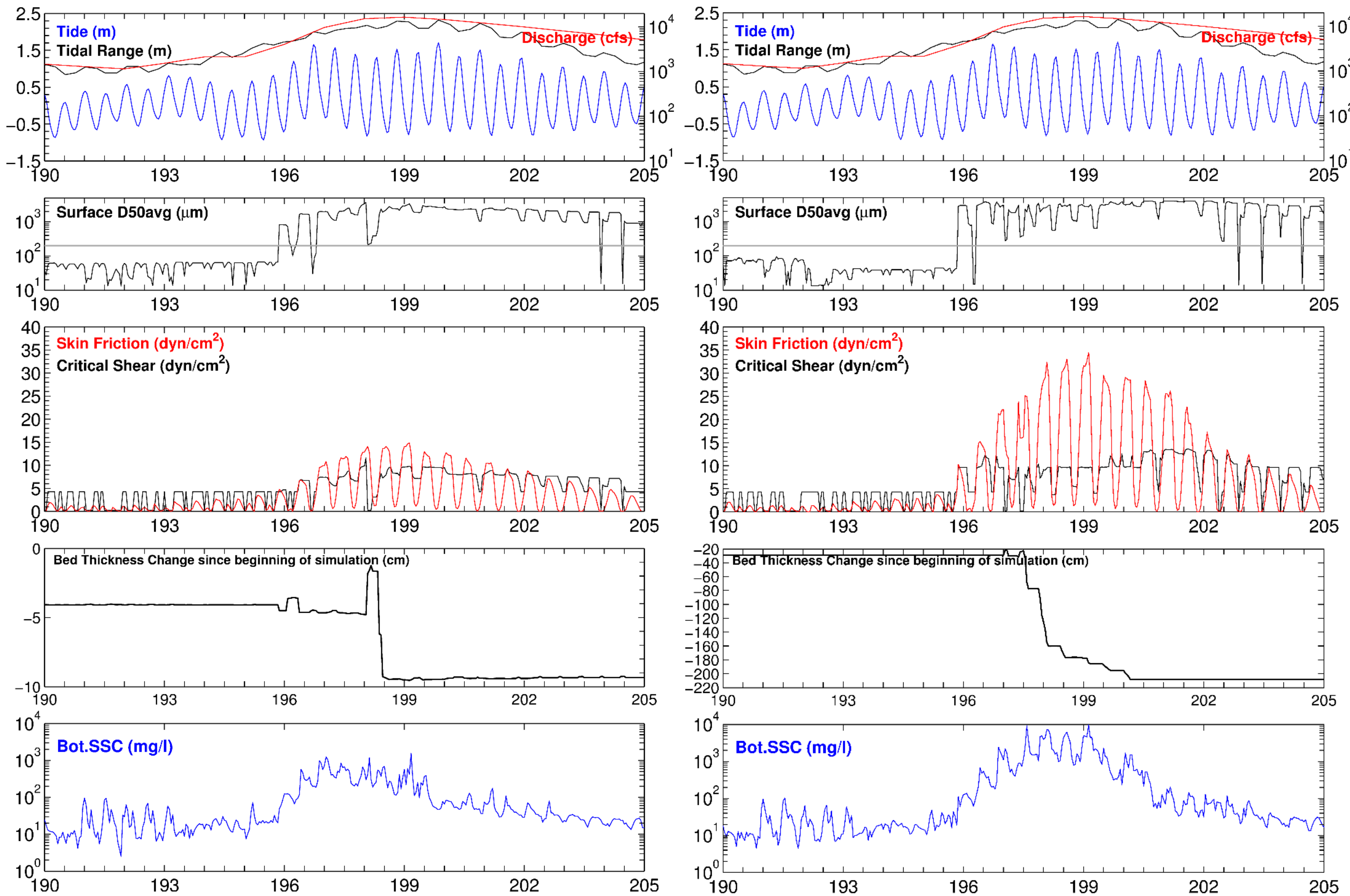

Figure 2. Bed mechanics at RM 4.2 (model cell 17,139) during the April 2007 storm event. Left panel shows results from the calibration run (constant D50), and right panel shows results from sensitivity run with time-variable D50.

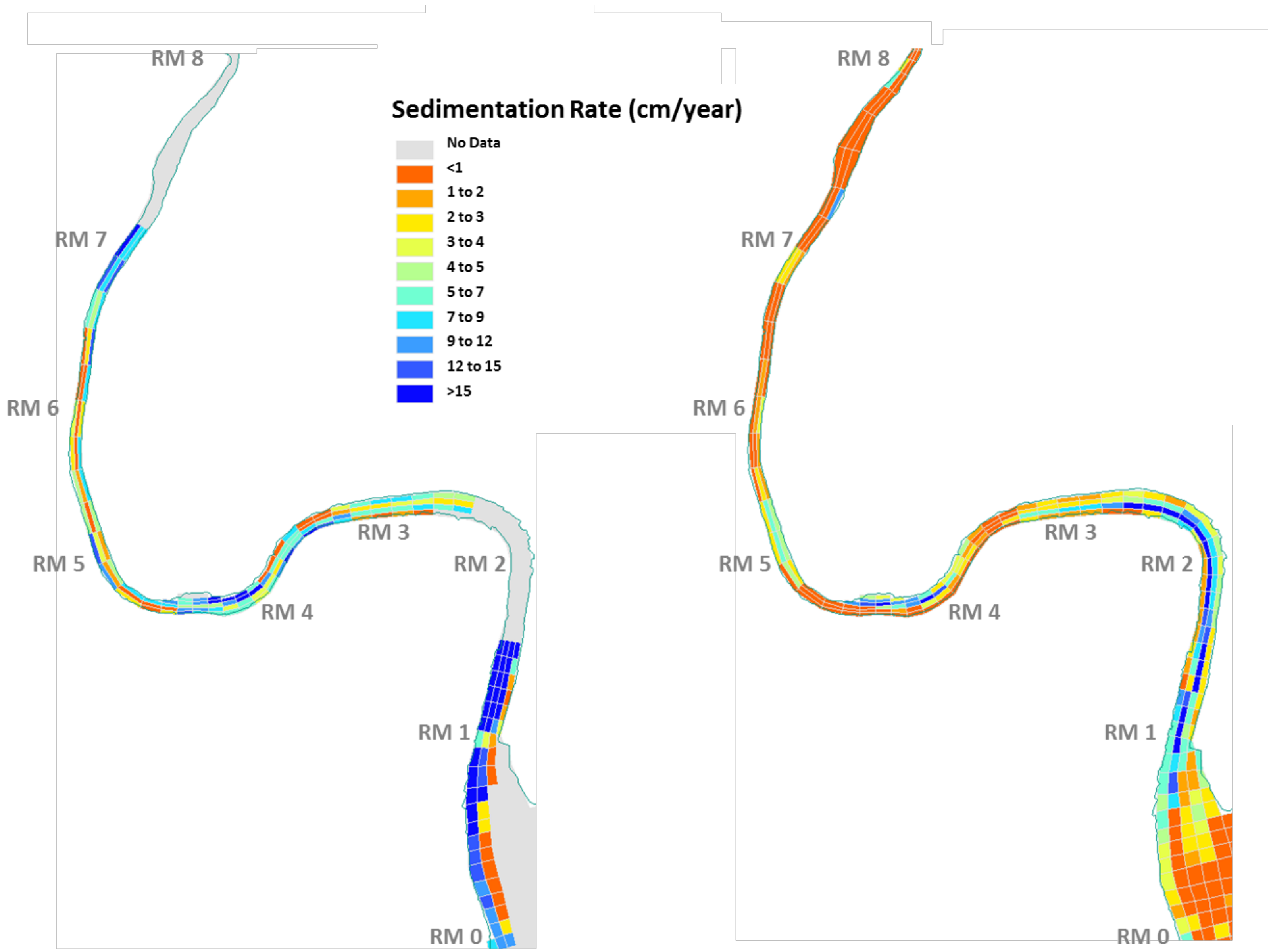

Figure 3. Measured historical infill rates and model simulated. Data (left panel) and model (right panel)

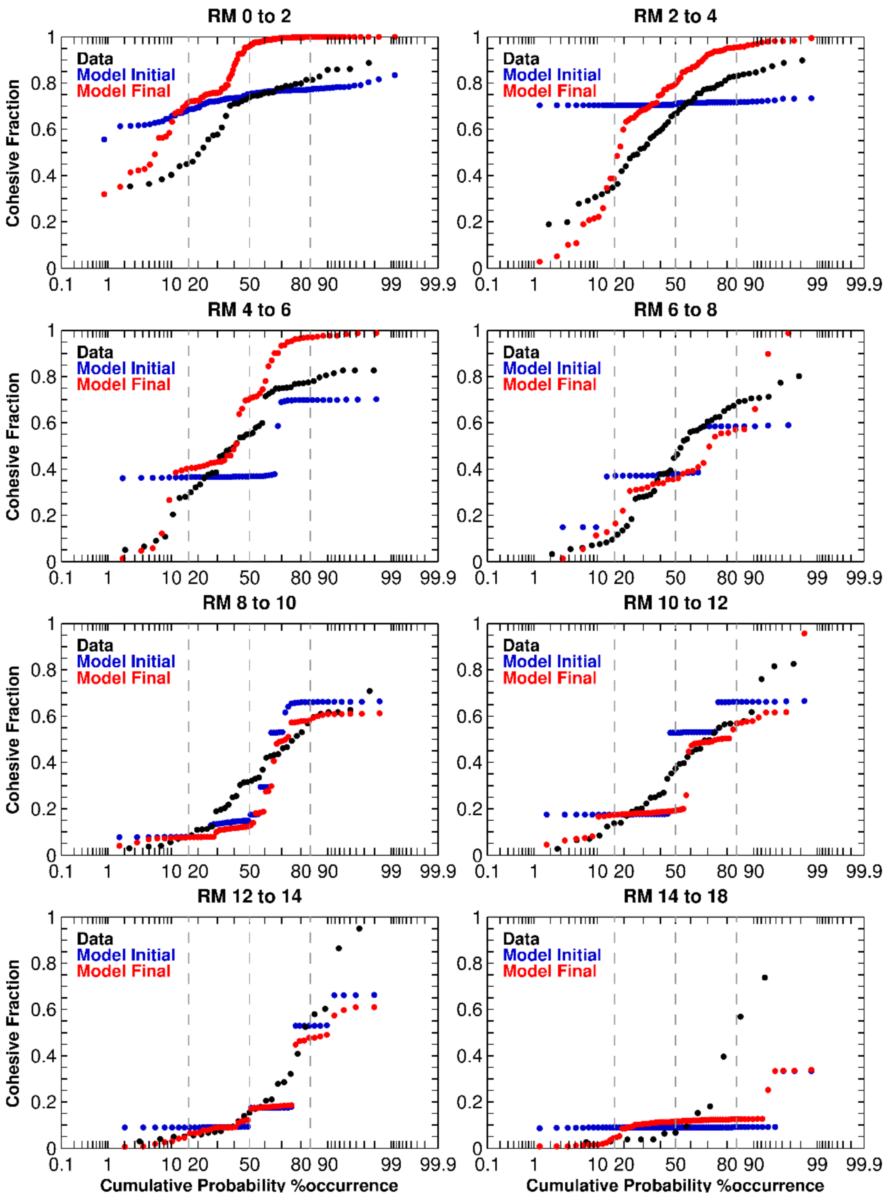

Figure 4. Cumulative probability distributions comparing the initial and final composition calculated by the model for top 15cm of the sediment bed to LPRSA core data. Model results are from the historical infill simulation.

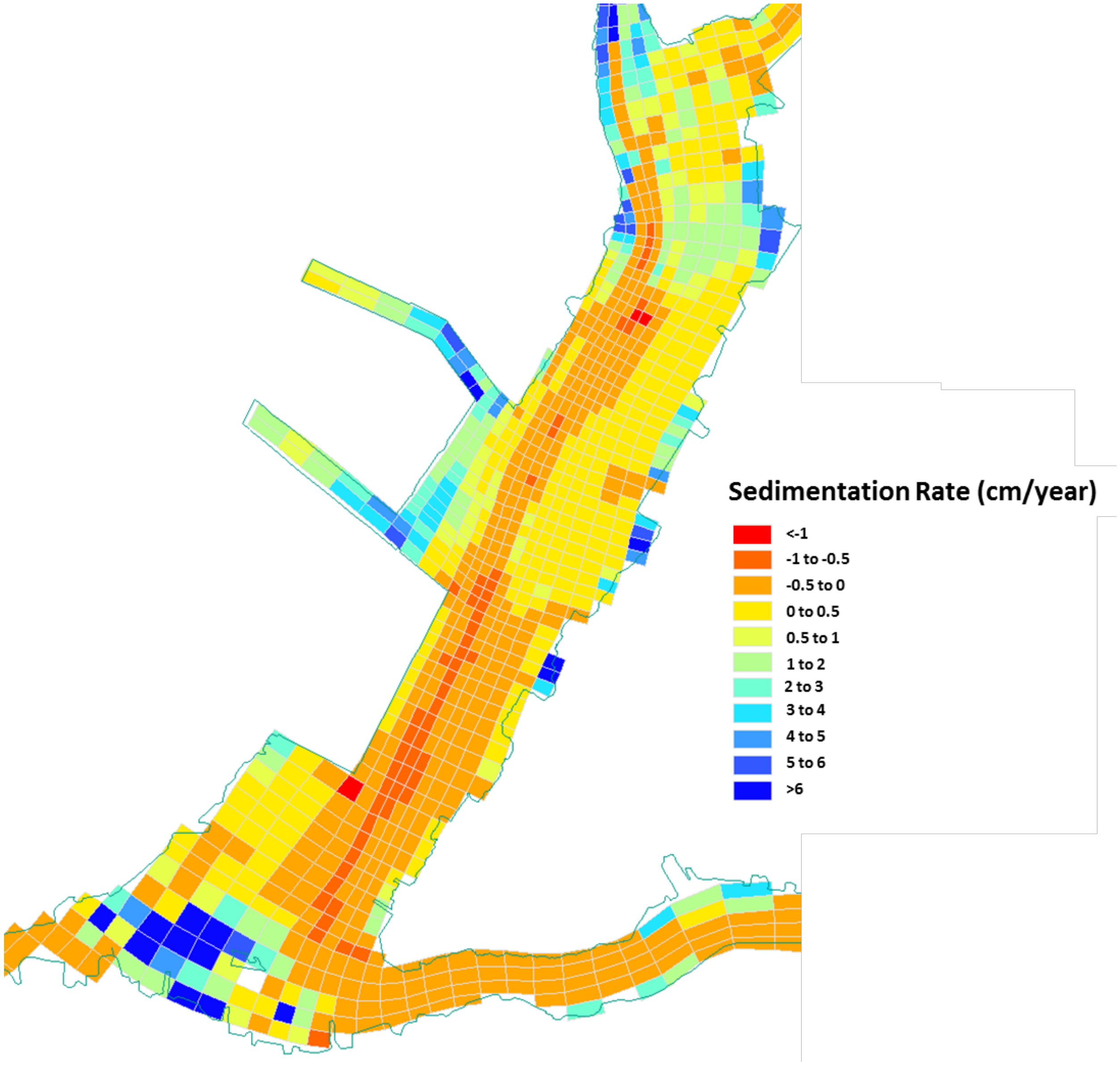

Figure 5. Model simulated sedimentation rates in Newark Bay in the historical infill simulation.

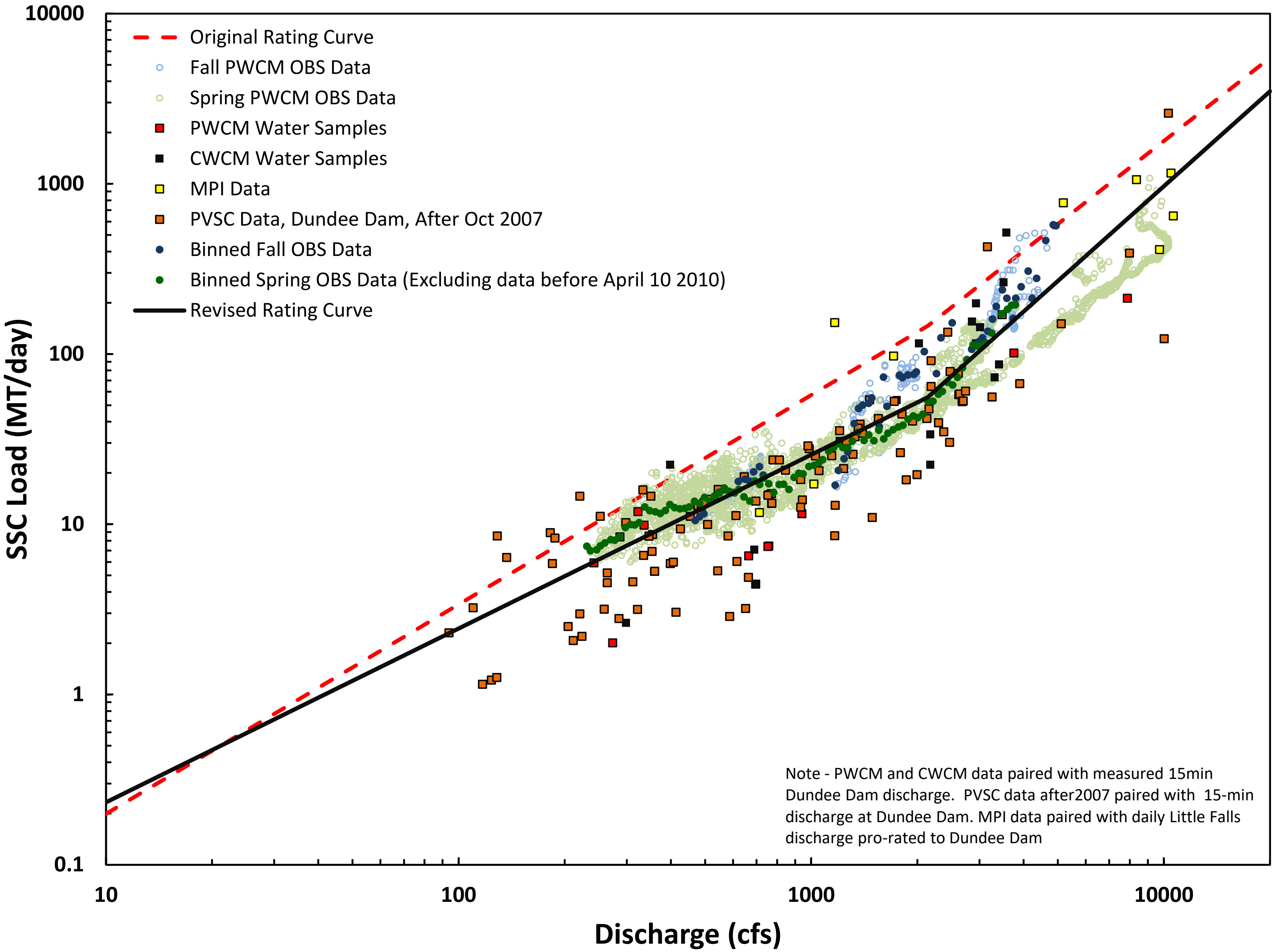

Figure 6. Suspended solids load versus discharge at Dundee Dam; data and rating curve

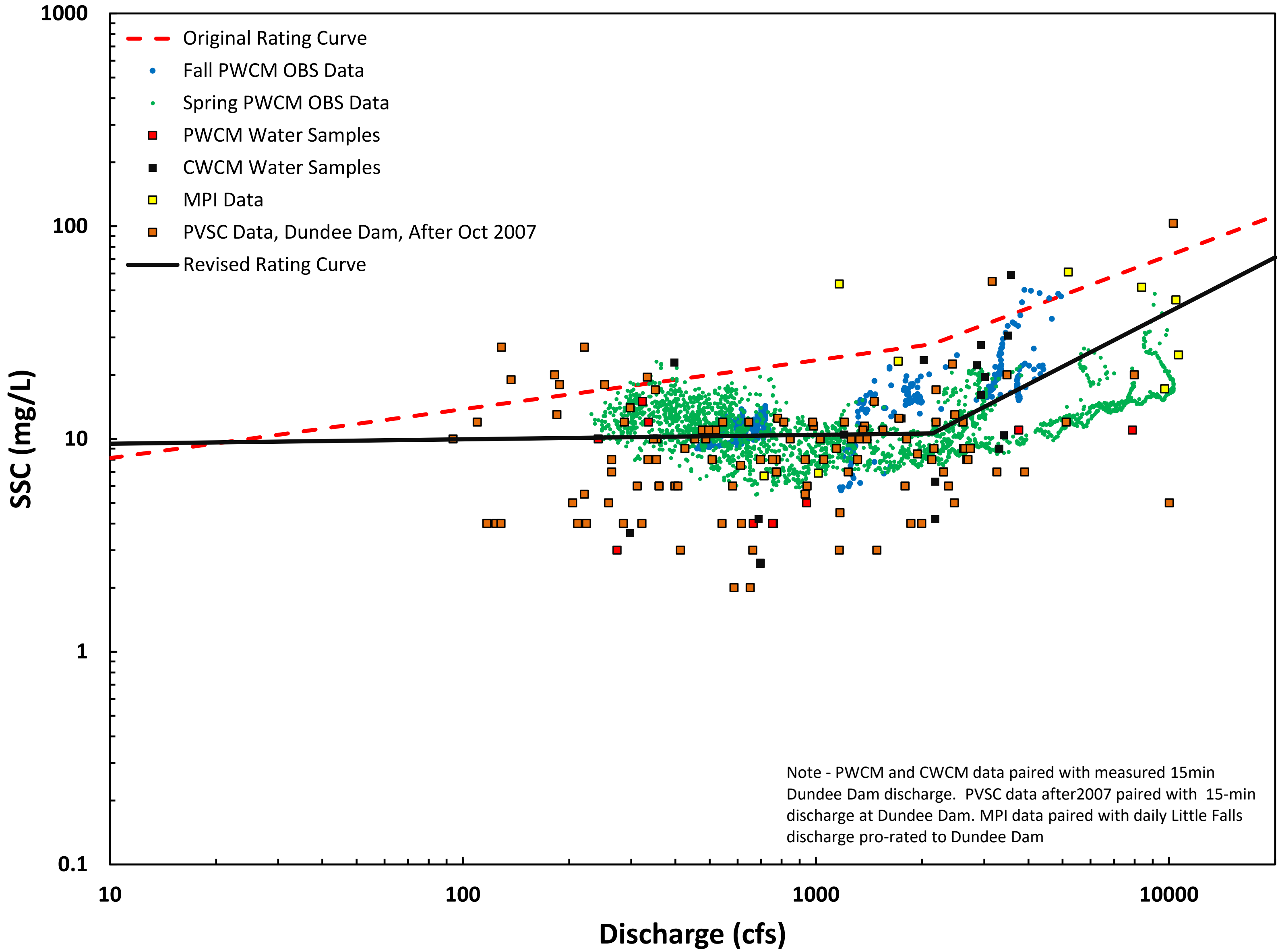

Figure 7. Suspended sediment concentrations versus discharge at Dundee Dam; data and rating curve derived estimates

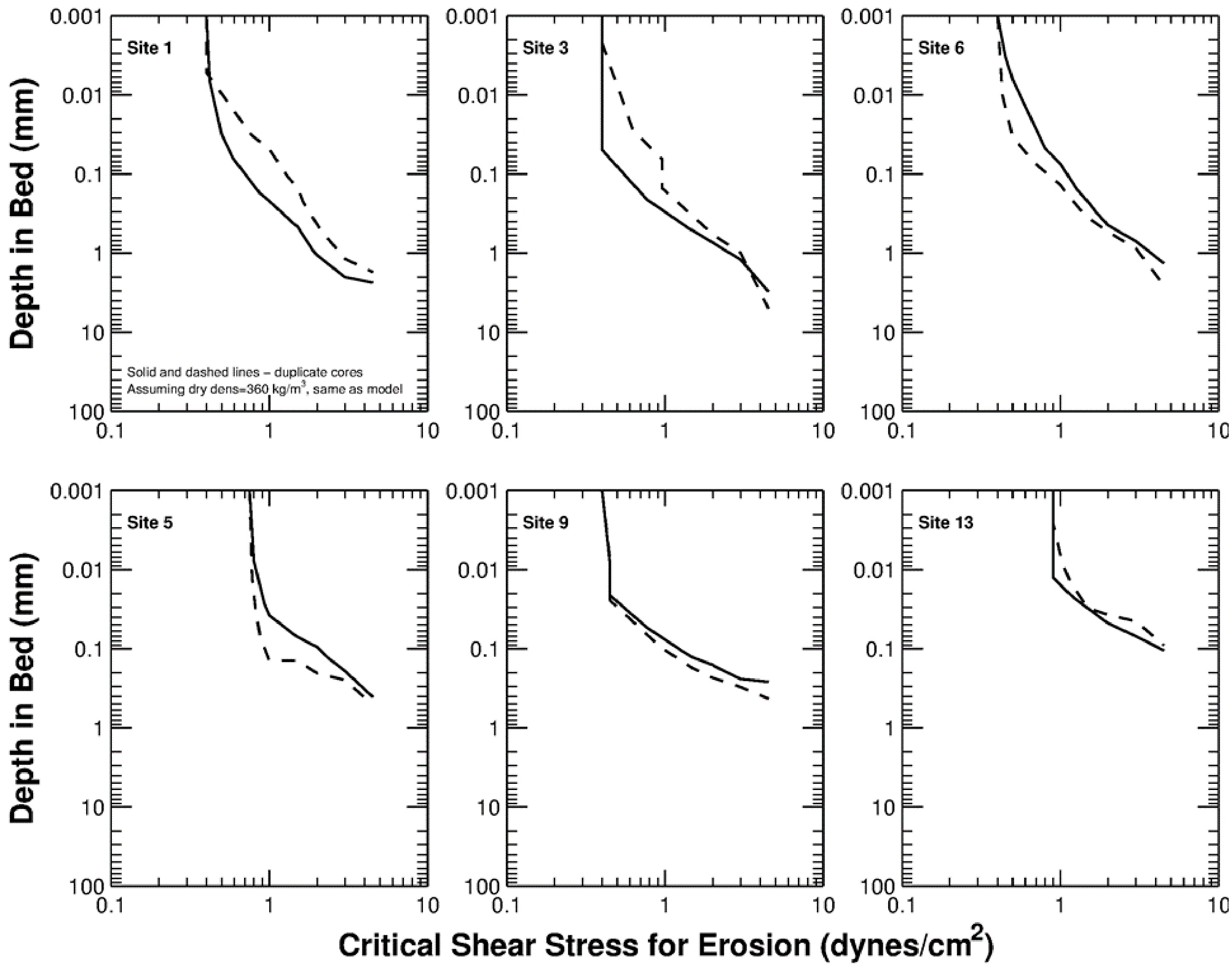

Figure 8. Critical shear stress profile measured in Gust Microcosm experiments

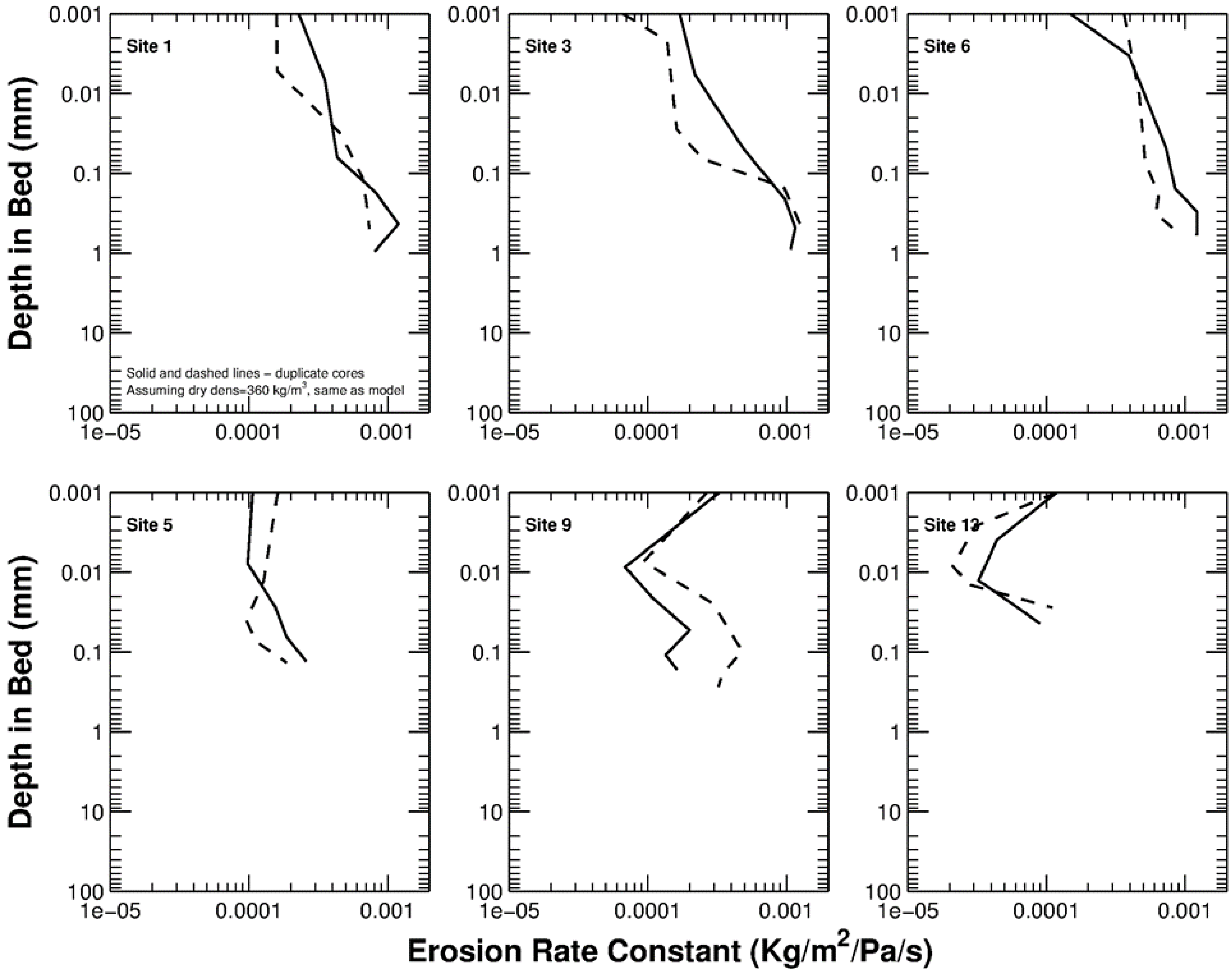

Figure 9. Profile of erosion rate parameter M measured in Gust Microcosm experiments

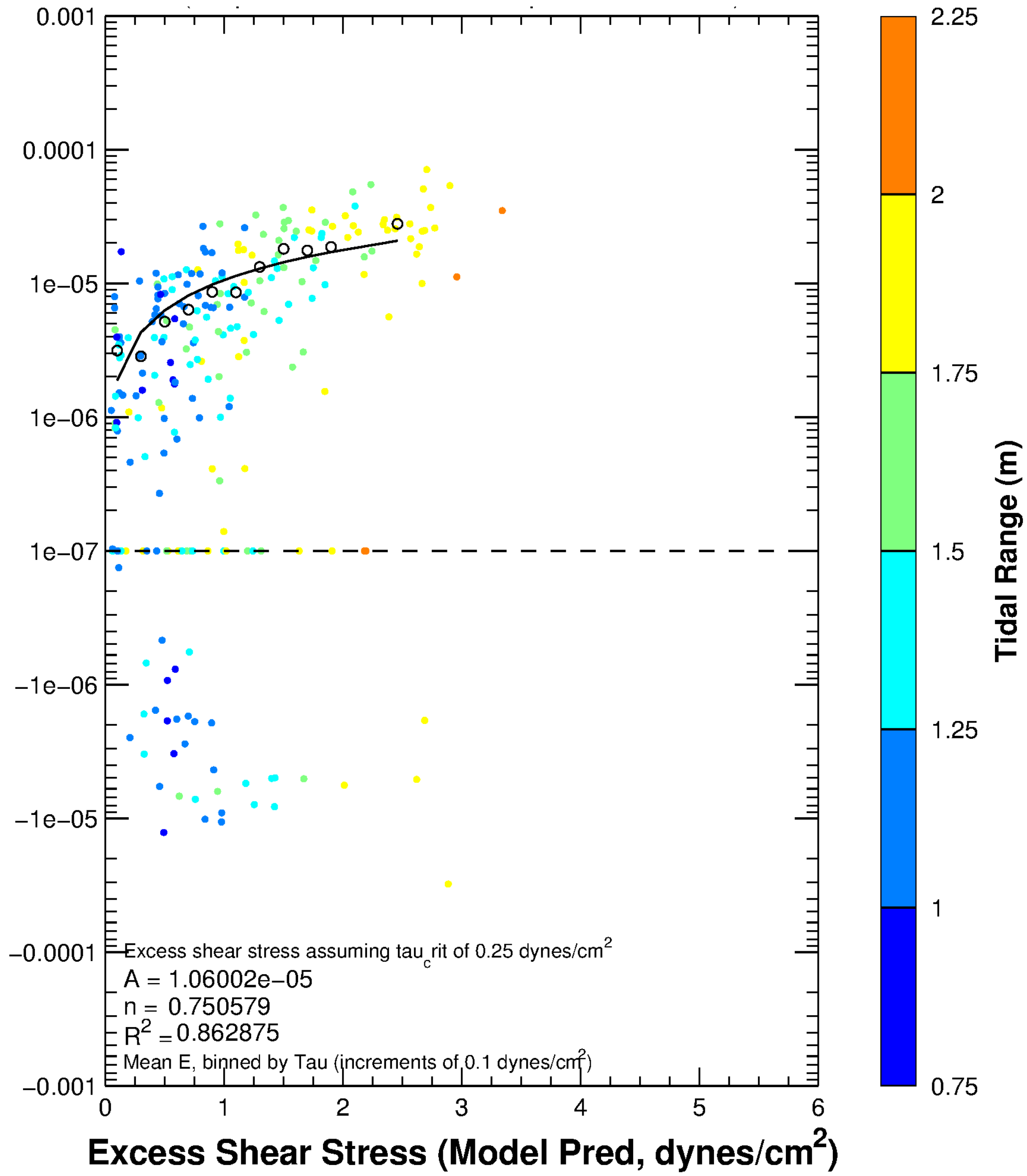

Figure 10. Entrainment rate from PWCM data plotted versus excess shear stress assuming critical shear stress of 0.25 dynes/cm2

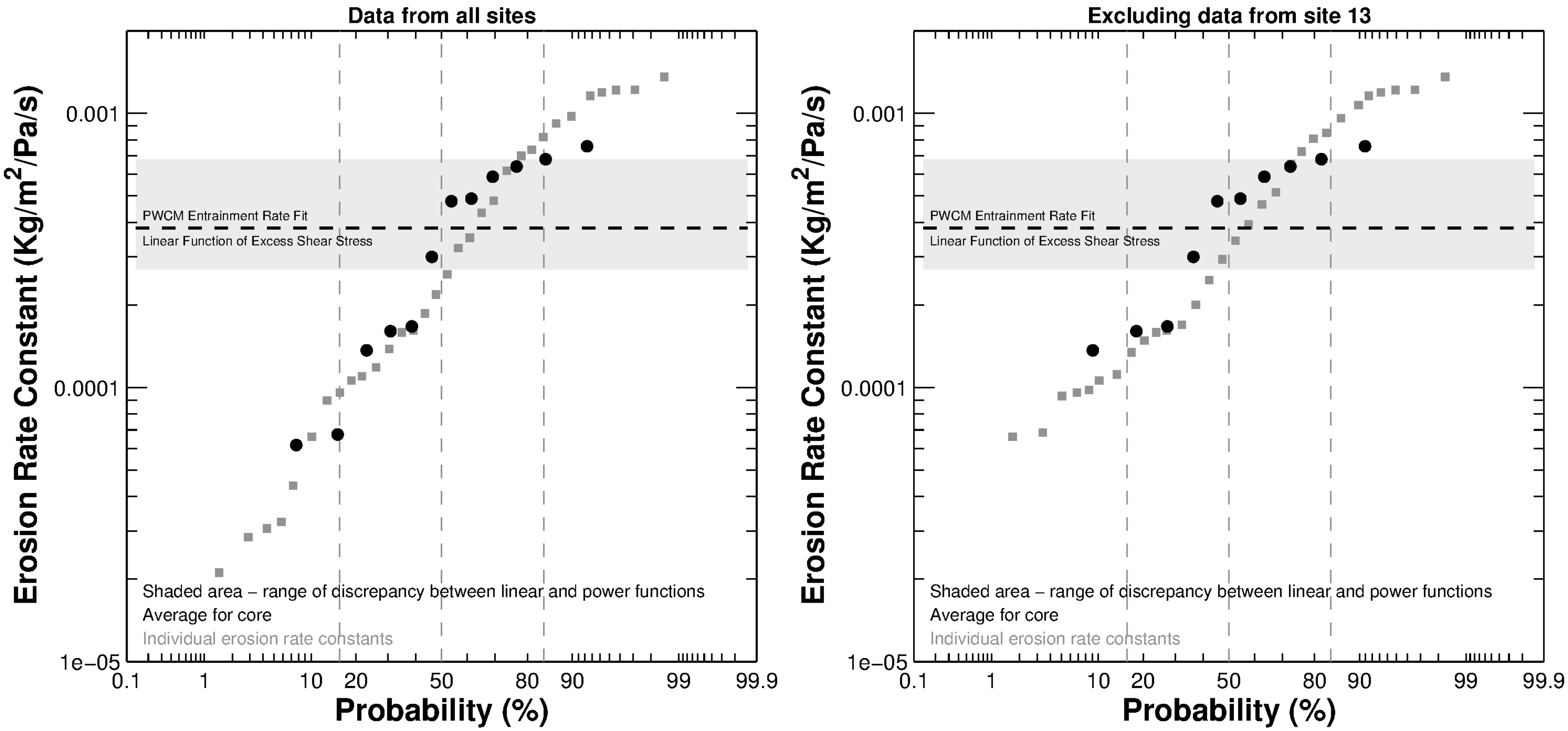

Figure 11. Probability distributions of erosion rate parameter measured in the Gust Microcosm experiments compared to the erosion rate parameter calculated from the PWCM data

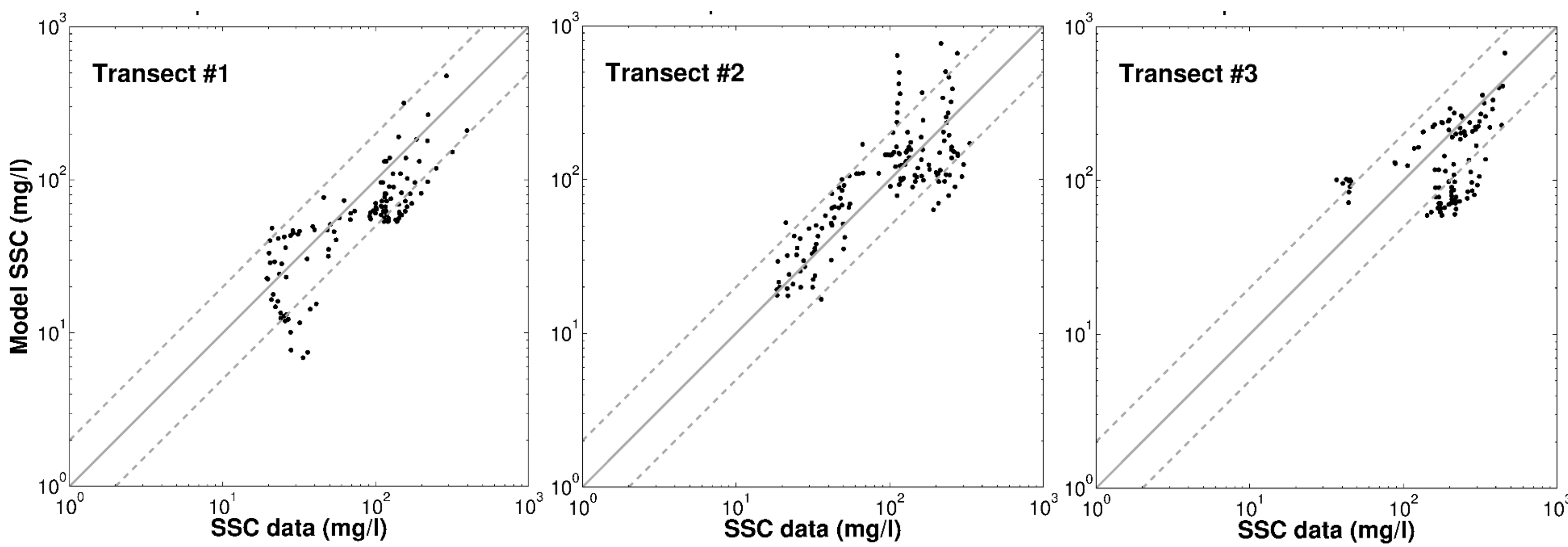

Figure 12. Model-data comparisons for the high-flow event on March 16, 2010

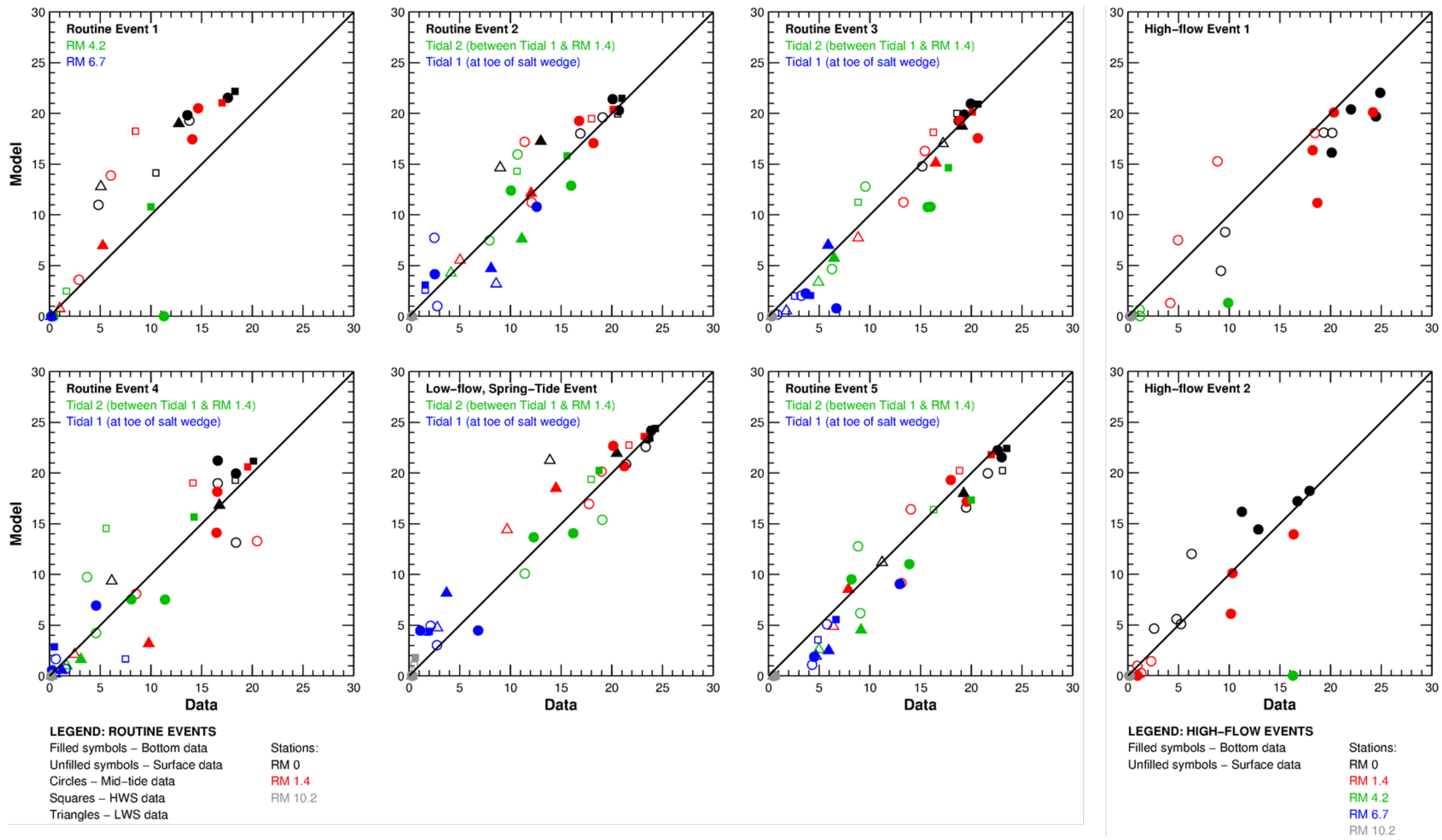

Figure 13. Model-data comparisons of salinity (PSU) during the CWCM events

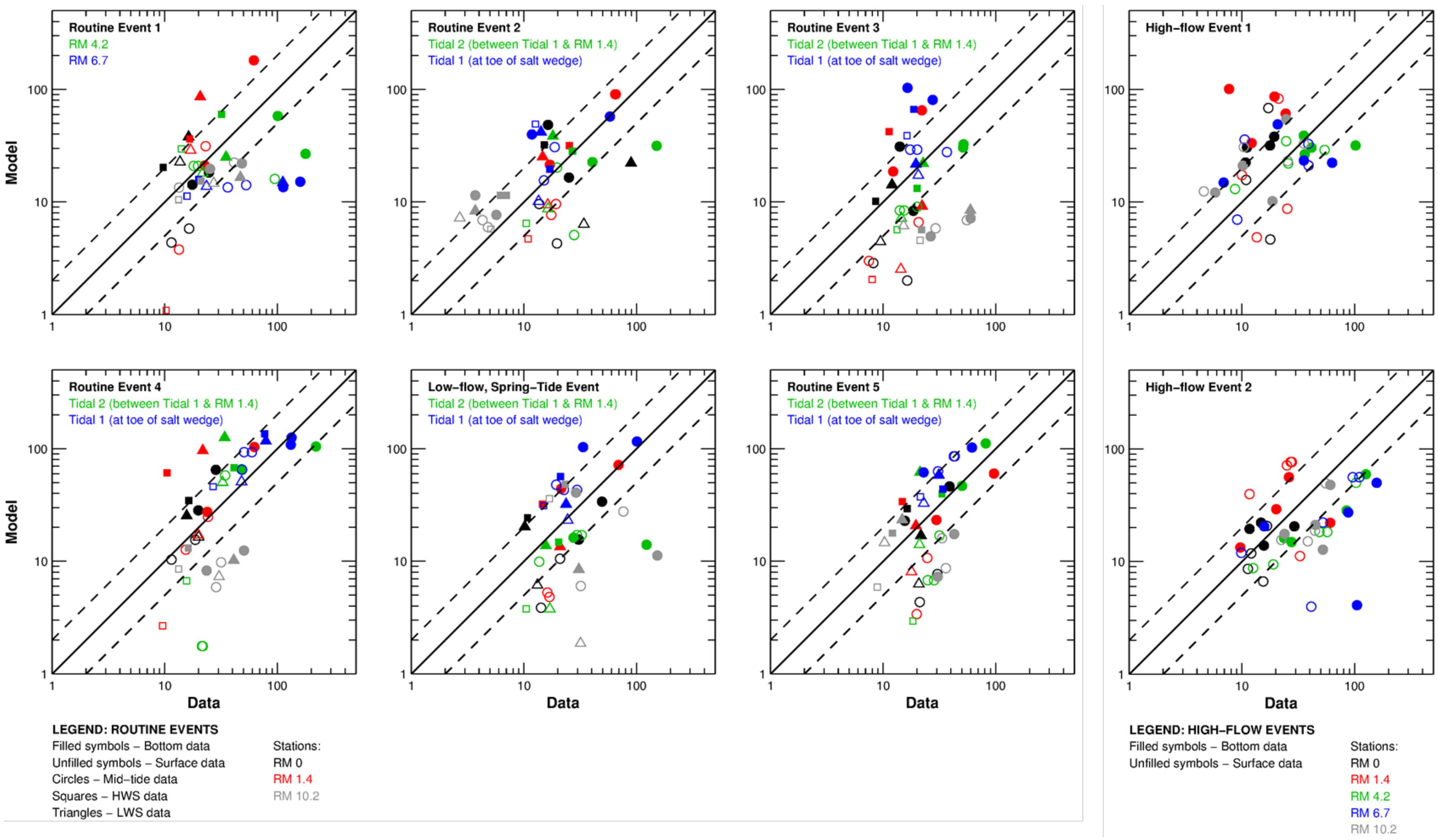

Figure 14. Model-data comparisons of suspended sediment concentrations (mg/L) during the CWCM events